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Attorney's Docket No. 24615.00300 - PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the application of: Peter David Stokes; Peter Winstanley Bodle	Examiner:
For: EMERGENCY LIGHTING	Group Art Unit: 2875
Serial No.: 09/911,184	
Filed: July 23, 2001	

TRANSMITTAL LETTER

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GB 0018063.8	25 July 2000
GB 0020956.9	25 August 2000
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Respectfully submitted,
Crosby, Heafey, Roach & May
Professional Corporation

Dated: December 17, 2001

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1.	Your reference	JL2564
2.	Patent application number *(The Patent Office will fill in this part)*	**0018063.8**
		25 JUL 2000
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	STG Aerospace Ltd Narborough Norfolk PE32 1TE
	Patents ADP number *(if you know it)*	7947419001
	If the applicant is a corporate body, give the country/state of its incorporation	England
4.	Title of the invention	Improvements in or Relating to Emergency Lighting
5.	Name of your agent *(if you have one)*	Barker Brettell
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	138 Hagley Road Edgbaston Birmingham B16 9PW
	Patents ADP number *(if you know it)*	7442494002

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IMPROVEMENTS IN OR RELATING TO EMERGENCY LIGHTING

This invention concerns improvements in or relating to emergency lighting, especially emergency lighting used to indicate an escape path leading to an exit for evacuation of a passenger vehicle in an emergency, for example following an accident.

The invention has particular application to passenger vehicles of the type in which rows of seats are provided on either side of an aisle with an exit at one or both ends of the aisle and/or on one or both sides of the aisle between the ends. Examples of this type of passenger vehicle include aircraft, trains and coaches.

Vehicles of this type are designed to carry a large number of passengers in a confined space. For example, each row may seat two or three passengers on each side of the aisle which is normally only wide enough for one passenger to move along between the aisle seats.

As a result, there may be several passengers in each row who have to access the aisle one at a time and move along the aisle to an exit. Furthermore, as passengers move along the aisle, they obstruct and restrict access to the aisle of other passengers in the rows. It will be understood therefore that passengers must keep moving along the aisle towards the exit(s) to evacuate the vehicle in an efficient, orderly manner. Accordingly, there is a need to ensure that passengers can find their way to the exit(s) easily and reliably.

In most vehicles of this type, an electrical lighting system is fitted at ceiling level which provides sufficient lighting for passengers to evacuate the vehicle under normal circumstances. However, in an emergency following an accident, the electrical lighting system may be inoperable if

the electrical connections to the power source are damaged. For example, the electrical connections may be broken by impact damage to the structure of the vehicle or by outbreak of a fire following a crash. Moreover, even if the lighting system remains operable, the outbreak of fire may render the lighting system ineffective if the light is blocked by smoke filling the interior of the vehicle.

The lighting system may also fail in other circumstances without an accident due to faults arising in normal service making it difficult for passengers to leave the vehicle safely at night or in conditions of low ambient light.

For these reasons, it is desirable, and in the case of aircraft mandatory, to provide an emergency lighting system as a back-up to the normal lighting system. Typically, such emergency lighting is provided at floor level and identifies the path leading to the exit(s) for passengers to follow. In this way, if the interior of the vehicle fills with smoke, the emergency lighting is below the smoke level allowing passengers to crawl to the exit(s) along the path illuminated by the emergency lighting.

Traditionally, such emergency lighting has been electrical with the wiring and power source separate from that of lighting system provided at ceiling level for normal use. The provision of a separate emergency lighting system adds considerably to the costs for initial installation and subsequent maintenance in service with regular checks to ensure operability. In the case of aircraft, the system must be checked each time before take-off and the aircraft is grounded if any repairs are required. The resulting delay is inconvenient for passengers and adds to the running cost for the aircraft operator, especially if a take-off slot has to be vacated.

A further problem of such electrical emergency lighting systems is the extra weight of the storage batteries normally employed as the separate power source which adds to operating costs. Thus, fuel costs may be increased and/or, in the case of aircraft, the number of passengers may have to be reduced to compensate for the extra weight.

The most important disadvantage of the known electrical emergency lighting systems however, is probably that they suffer from the same problem of the electrical connections being broken in a crash resulting from structural damage to the vehicle and/or from fire. Accordingly, such emergency lighting systems can be rendered inoperative just at the very time they are required to assist passengers to evacuate the vehicle.

It is desirable therefore to provide an emergency lighting system which does not depend on electrical connections to a power source to provide the required level of illumination. One such system for use in an aircraft is described in our UK Patent No.2 314 536 in which the path to the exit(s) is illuminated by photoluminescent material incorporated into a track extending along the aisle for passengers to follow to the exit(s). The photoluminescent material is chosen to provide an acceptable level of illumination over a period of time sufficient for the passengers to evacuate the aircraft.

The emergency lighting system described in our afore-mentioned patent has met with considerable success due to the many benefits and advantages for both the manufacturer and operator of aircraft in which the system is fitted. Thus, the system does not require connection to a power source thereby eliminating completely the wiring and separate storage batteries required for conventional electrical emergency lighting systems.

In one arrangement, the track includes a base and a cover which are releasably connected together to locate and retain an insert provided with the photoluminescent material. The base and cover are made of plastics such as polycarbonate with at least the cover being transparent or translucent to allow the light emitted by the photoluminescent material to pass through.

By forming the track in this way, when a cover is worn or damaged in service, a replacement cover can be fitted to the existing base and insert allowing the track to be repaired with minimum delay and disruption. In this way, cost savings can be made for maintenance of the track. There can be occasions, however, when it is more convenient to replace the entire track, for example during refurbishment of an aircraft, and in these circumstances the insert may be recovered and re-used. This may allow further cost savings to be made.

The track is generally employed in the passenger cabin where carpets are fitted which may be butted against the base member with the cover member overlying the cut edges of the carpet to provide a neat finish. In the galley, a washable floor covering is typically provided in preference to carpet to allow the floor to be washed to maintain the required hygiene levels and the track may not be suitable for installation in this area.

An alternative arrangement for use in the galley is described in our earlier patent in which the track is inset into a channel formed in the flooring material. In this arrangement, the base of the track is formed by the flooring material itself and the cover is fitted over the photoluminescent insert within the channel in the flooring material.

Both arrangements can provide traps for dirt or liquid to collect which may increase the time spent in cleaning and maintaining the track.

The present invention has been made from a consideration of the problems aforementioned and is intended to provide an improved photoluminescent track for emergency lighting systems for passenger vehicles and in particular for aircraft.

According to a first aspect of the invention, we provide a photoluminescent track for an emergency lighting system comprising an elongate hollow outer member having an upper wall and a lower wall connected by opposed side walls to define a longitudinally extending slot, and an elongate inner member extending lengthwise of the slot and having photoluminescent material covered by the upper wall of the outer member, wherein the inner member is slidable lengthwise of the slot for push-fitting from one end of the slot, and the upper wall of the outer member is made a material to transmit light emitted by the photoluminescent material.

By this invention, the inner member provided with the photoluminescent material is enclosed and surrounded along the length of the track by the outer member which is formed in one piece. In this way, the problem of dirt or liquid being trapped by the track may be reduced enabling savings of time in cleaning and maintenance of the track to be achieved. Furthermore, when the track is replaced, the inner member provided with the photoluminescent material can be removed from the slot and re-used.

The slot is preferably closed by attaching a thin closure strip of a material such as metal foil to the outer member by adhesive or any other suitable means. In this way, the slot is sealed to retain the inner member within the outer member and the closure strip can be removed or ruptured if it is desired to remove the inner member.

In a preferred arrangement, the outer member is formed with the slot open at both ends so that the inner member can be inserted from either end of the outer member with both ends of the slot being closed by attaching a closure strip to seal the inner member in the outer member. Furthermore, the provision of the closure strips does not significantly alter the length of the outer member allowing discrete lengths of track to be butted together.

In an alternative arrangement, the outer member is formed with the slot open at one end and closed at the other end so that the inner member can be inserted from one end only which is then closed by attaching a closure strip to seal the inner member in the outer member. With this arrangement only one closure strip is required.

The inner member is preferably the same or substantially the same length as the outer member. In this way, discrete lengths of the track can be butted end to end with no perceptible break in the light emitted between adjoining lengths of the track. More preferably, the inner member is the same or substantially the same length and substantially the same width as the outer member. In this way, light is emitted over substantially the whole surface area of the track.

The outer member may be a moulding or extrusion of transparent or translucent plastics material such as polycarbonate although it will be understood that other plastics materials may be used. Preferably, the plastics materials form a substantially rigid outer member which can withstand loads applied to the track, for example people walking on the track, and which is resistant to cleaning fluids or other liquids which may come into contact with the track. The plastics material may also be fire resistant to reduce or prevent the generation of smoke or hazardous fumes.

The inner member preferably comprises a base of sheet metal such as aluminium provided on one side with a layer of photoluminescent material and an optional UV protective cover layer on top of the photoluminescent layer. A light coloured base layer may be provided under the photoluminescent layer. By the use of a metal base, the inner member is sufficiently rigid for push fitting in the slot from one end of the outer member even where the outer member is of long length. Furthermore, the inner member can be made relatively thin which in turn allows the depth of the outer member to be kept to a minimum. As a result, the track may be produced with a low profile which enables the same track to be used in carpeted and non-carpeted areas of a vehicle.

The track may be retro-fitted to a vehicle after manufacture either to provide an emergency lighting system or to replace an existing emergency lighting system. Alternatively or additionally, the track may be fitted as original equipment during manufacture of a vehicle.

Where the track is fitted as original equipment, it may be pre-assembled to components for assembly of the vehicle. For example, for installation of the track on the floor of the vehicle, it is envisaged that the track may be attached to the floor panels for assembly of the vehicle. The track may be manufactured in pre-determined lengths corresponding to the size of the floor panels. In this way, the track is built-in during assembly of the vehicle and a separate assembly operation to install the emergency lighting system is avoided.

Thus, according to a second aspect of the invention, we provide a component for use in the construction of a vehicle wherein the component is provided with a photoluminescent track to define an escape route in the assembled vehicle.

Preferably, the component is a floor panel employed in the construction of an aircraft and the photoluminescent track is arranged to extend on one side of an aisle leading to an exit. More preferably, the floor panel is provided with a pair of laterally spaced photoluminescent tracks that are arranged to extend on opposite sides of the aisle to identify the boundaries of the aisle and define an escape path between the tracks leading to the exit. In a preferred arrangement, the component is provided with the photoluminescent track according to the first aspect of the invention.

According to a third aspect of the invention, we provide a vehicle, preferably an aircraft, having rows of seats on either side of an aisle, and a photoluminescent track according to the first aspect of the invention extending along each side of the aisle to identify the boundaries of the aisle and define therebetween an escape path leading to an exit at one or both ends of the aisle and/or between the ends of the aisle.

Preferably, the photoluminescent track is mounted on the floor and is substantially continuous along each side of the aisle leading to an exit. In this way, the escape route is not obscured by people moving along the aisle between the tracks. As a result, there is less risk of people leaving the aisle and becoming trapped between the rows of seats.

Advantageously, the track includes markings to indicate the route to an exit. For example, the track may be provided with arrows or similar direction indicators to show where an exit aisle leads from the main central aisle to an exit. Alternatively or additionally, the word "exit" or the like may be provided in the track. Some form of direction indicator is generally preferred however as avoiding problems with language and/or reading words.

The markings may be formed with photoluminescent material on the inner member so as to emit light of a different colour to the rest of the track. In this, the light output from the track is not reduced by the provision of the markings. This feature of the markings assists the smooth, continuous movement of passengers towards the exit thereby facilitating the evacuation of the vehicle in an emergency.

Typically, on each side of the aisle, the seats in each row are provided by a demountable multi-seat unit allowing the number and arrangement of seats to be altered. For example, seat units comprising two, three or four seats may be provided. These units are normally of different width with the result that the width of the aisle between seat units on each side can change when one seat unit is replaced by another seat unit with more or less seats. This can lead to problems where an emergency lighting system is provided by a floor mounted track. In particular, if a wider seat unit is fitted which extends over the track, the escape path may be concealed.

The position of the floor mounted track is fixed on installation of the emergency lighting system and, to accommodate changes in the seating layout, it is preferred to provide the seat units with a photoluminescent track on the side of the aisle seat, preferably close to the floor. The track on the aisle seats is provided in addition to the existing floor track and will provide an escape route for passengers to follow where the floor track is concealed by the seat unit. In this way, the appearance of a substantially continuous track along each side of the aisle leading to an exit may be maintained without modification to the floor track.

Thus according to a fourth aspect of the invention, we provide in or for an aircraft having rows of seats on each side of an aisle and a photoluminescent track extending along each side of the aisle at or near floor level, at least one row including a demountable multi-seat unit on at

least one side of the aisle such that the width of the aisle may be altered by fitting any selected one of a plurality of demountable multi-seat units of different width, wherein a photoluminescent track is provided on that side of the multi-seat unit which, in use, is arranged adjacent to the aisle.

Preferably, the track comprises a strip of photoluminescent material overlaid by a cover of transparent or translucent material attached to the seat unit to locate and retain the photoluminescent strip in place. The photoluminescent strip may be the same or similar to the inner member of the track according to the first aspect of the invention.

The invention will now be described in more detail by way of example with reference to the accompanying drawings, wherein:-

Figure 1 is a perspective view of a track embodying the invention;

Figure 2 is a side view of the track shown in Figure 1;

Figure 3 is an end view of the track shown in Figure 1;

Figure 4 is a plan view of the track shown in Figure 1;

Figure 5 is an enlarged cross section of the insert of the track shown in Figure 1;

Figure 6 shows a general arrangement of an emergency lighting system incorporating the track of Figures 1 to 5 in an aircraft;

Figure 7 shows a detail of the emergency lighting system shown in Figure 6 in the region of an emergency exit;

Figure 8 shows schematically the general arrangement of an emergency lighting system incorporating the track of Figures 1 to 5 in an aircraft having interchangeable seat units; and

Figure 9 shows a detail of the aisle seat of an interchangeble seat unit for the emergency lighting system of Figure 8.

Referring first to Figures 1 to 5 of the drawings, a photoluminescent track 1 is shown comprising an elongate hollow housing 2 of uniform, generally rectangular cross-section and an elongate insert 3. The housing 2 has flat upper and lower walls 2a and 2b respectively connected by opposed side walls 2c, 2d to define therebetween a substantially rectangular slot 4.

The insert 3 has a width 'w' and thickness 't' slightly less than the corresponding dimensions of the slot 4 to provide limited clearance for push-fitting the insert 3 in the slot 4 from one end of the housing 2. The insert 3 extends the length of the slot 4 between the ends of the housing 2 and the width of the slot 4 between the sides of the housing 2.

As best shown in Figure 4, the insert 3 comprises a base 3a of sheet aluminium covered on one side by a layer 3b of photoluminescent material overlaid with a UV protective layer 3c of clear plastics or lacquer. The use of aluminium for the base 3a has advantages over the vinyl base employed for the insert described in our earlier patent.

In particular, we have found that adhesion of the layer 3b of photoluminescent material is improved and that chemical interaction between the insert 3 and the housing 2 is eliminated or significantly reduced. We have also found that using aluminium for the base 3a in place of vinyl improves the fire resistance and/or smoke generation characteristics of the insert 3.

In this embodiment, the photoluminescent material emits a yellow light that is visible when the level of ambient light from natural or artificial light sources is low. It will be understood that photoluminescent material which emits other colours of light may be employed. Further details of suitable photoluminescent materials are provided in our afore-mentioned earlier patent the disclosure of which is incorporated herein by reference.

The housing 2 is a moulding of a rigid plastics such as polycarbonate which transmits the light emitted by the photoluminescent material. The plastics may also be fire resistant. In this embodiment, the housing 2 is formed in lengths of 1 metre which may be cut into shorter lengths as desired for any required application.

It will be understood, however, that the housing 2 can be formed in longer or shorter lengths and in fact a range of standard lengths may be provided for selection and fitment in the appropriate combination for any given installation.

The insert 3 is cut to the length of the housing 2 and is a push-fit in the slot 4 from one end of the housing 2 with the layer 3b of photoluminescent material uppermost. The insert 3 is sufficiently rigid by virtue of forming the base 3a from sheet aluminium to allow push fitting for any length of housing 2. This is a further advantage of using aluminium for the base 3a in place of vinyl.

The insert 3 is enclosed and surrounded by the housing 2 along the length of the track and the slot 4 is closed at each end by a metal foil (not shown) or similar sheet material bonded to the end faces of the housing 1, for example by adhesive or any other suitable means.

In this way, the slot 4 is sealed to encapsulate and protect the insert 3 in the housing 2 when the track 1 is in use, and, when the track 1 is replaced, the insert 3 can be removed by rupturing the foil and sliding the insert 3 out of the housing 2 allowing the insert 3 to be re-used.

With reference now also to Figures 6 and 7, the general layout of an emergency lighting system incorporating the track 1 is shown in an aircraft 10 having a plurality of rows of seats 11 disposed on either side of a main aisle 12 extending the length of the passenger compartment or cabin 13.

A rear exit 10a is provided at the back of the cabin 13 and a pair of front exits 10b, 10c are provided on opposite sides of the cabin 13 at the front. The exits 10a, 10b, 10c are employed for passengers to get on and off the aircraft both in normal use and in an emergency.

A further pair of exits 10d, 10e are provided on either side of the cabin 13 approximately mid-way between the ends of the aisle 12, usually opening over the wings (not shown) of the aircraft 10 and which are only used in an emergency.

The track 1 is laid on each side of the main aisle 12 adjacent to the aisle seats 11a to define an aisle path 14 extending from the rear exit 10a the length of the cabin 13 between the aisle seats 11a.

At the front of the cabin 13, the track 1 is laid on each side of a pair of exit aisles 15, 16 extending from the main aisle 12 to the front exits 10b, 10c respectively.

Between the ends of the main aisle 12, the track 1 is laid on each side of another pair of exit aisles 17, 18 extending from the main aisle 12 to the centre exits 10d, 10e respectively.

The track 1 is formed in lengths which can be butted end to end or at right angles to define an escape route from any row of seats 11 in the cabin 13 along the main aisle 12 and exit aisles 15, 16, 17, 18 to the exits 10a, 10b, 10c, 10d, 10e.

As best shown in Figure 7, the track 1 incorporates markings such as arrows 19 to show where the exit aisles 17, 18 lead from the main aisle 12 to the centre exits 10d, 10e. The markings may be provided on the insert 3, for example by the use of a dye so that the marking glows with light of a different colour to the rest of the insert 3. In this way, the light output of the insert 3 is not reduced. Alternatively, the markings may be arranged to overlie and block the light emitted by the insert 3.

Similar markings may be provided to indicate where the exit aisles 15, 16 lead from the main aisle 12 to the exits 10b, 10c at the front of the aircraft 10, and also to indicate where the main aisle 12 leads to the exit 10a at the rear of the aircraft 10. The word 'exit' or the like may also be incorporated into the track 1 to reinforce the message provided by the arrows 19.

By the use of such markings, people approaching an exit aisle are provided with an advance warning as they approach an exit aisle 15, 16, 17, 18 and, on reaching an exit aisle 15, 16, 17, 18, are directed into the exit aisle 15, 16, 17, 18 towards the exits 10b, 10c, 10d, 10e.

The size and/or spacing of the markings may alter as the junction between the main aisle 12 and the exit aisles 15, 16, 17, 18 is approached to

provide a visual warning of the proximity of the exit aisles 15, 16, 17, 18. For example, the arrows 19 may become smaller and more closely spaced together nearer the exit aisles 15, 16, 17, 18.

As a result, people can enter an exit aisle 15, 16, 17, 18 from the main aisle 12 with confidence assisting the smooth flow of people towards the exits 10a, 10b, 10c, 10d, 10e and reducing congestion. This is particularly important in an emergency where people may be confused and start to panic if the track 1 does not provide a positive indication of the route to an exit 10a, 10b, 10c, 10d, 10e. In this way, evacuation of the aircraft is facilitated in a simple and effective manner.

The track 1 can be retrofitted to existing aircraft to replace electrical emergency lighting systems with a photoluminescent system, for example during refurbishment, or it can be fitted as original equipment to provide new aircraft with a photoluminescent emergency lighting system.

Where the track 1 is fitted to new aircraft, it is envisaged that the track 1 could be incorporated into the structure of the aircraft at an early stage of the production. For example, the track 1 could be fitted to the floor panels prior to assembly

A particular feature of the track 1 according to the present invention is the low profile or depth of the track 1 such that it may be fitted in both carpeted and non-carpeted areas of the aircraft 10 with advantages for both the manufacture and installation of the track 1. In Figure 1, the track 1 is shown with the flooring material butted up against the flat sides of the track 1 and the flat upper surface of the track substantially flush with the flooring material.

In this way, installation of the track 1 does not present a safety hazard for passengers to trip over. Also, the upper surface of the track 1 is less susceptible to damage by people walking on the track 1 and/or from wheels of trolleys or cleaning equipment riding over the track 1. Moreover, cleaning the floor in which the track 1 is laid is facilitated and there are no areas for dirt or liquid to become trapped and cover the track 1. The upper surface of the track 1 may be given a surface hardening treatment to increase the resistance to damage, especially scratching which may impair the emission of light from the track 1.

Referring now to Figures 8 and 9, there is shown the arrangement of an emergency lighting system employing the track 1 of Figures 1 to 5 in an aircraft 20 having interchangeable demountable seat units 21 of different width.

The aircraft 20 has rows of seats 22 in two sections. In a first section, each row has six seats, three on each side of the main aisle 23. In a second section, each row has four seats, two on each side of the main aisle 23. The first section may be for economy class passengers and the second section for business class passengers.

Each group of three seats in the first section is provided by a demountable multi-seat unit 21a and each group of two seats in the second section is provided by a demountable multi-seat unit 21b. The units 21a are wider than the units 21b and aisle 23 is narrower between the units 21a in the first section than between the units 21b in the second section.

The photoluminescent track 1 extending along each side of the aisle 23 is arranged to identify the boundaries of the aisle 23 and the escape path defined therebetween is wider in the second section.

As a result, if the wider seat units 21a are fitted in the second section as shown in dotted outline in Figure 8 to increase the capacity of the aircraft 20, the width of the aisle 23 is reduced. This has the effect that the new boundary of the aisle 23 is no longer indicated by the existing track 1 which is now obscured by the wider seat units 21a. It will be understood this is but one example of the effect of changing one seating unit for another and that other arrangements and combinations of multi-seat units may give rise to the same problem.

To alleviate this problem without altering the layout of the existing track 1 on the floor of the aircraft 20, a photoluminescent track 24 is provided on the side of the aisle seat of the wider seat units 21a which overlie the floor track 1. In this way, the track 24 identifies the boundary of the aisle 23 and defines an escape path between the seat units which the passengers can follow to evacuate the aircraft 20.

As best shown in Figure 9, the aisle seat has a side panel 25 and the track 24 is located on the side facing the aisle at the bottom of the panel 25 close to the floor. The track 24 is formed by a strip of the insert 3 which can be mounted in a frame or carrier (not shown) releasably attached to the side panel 25 to overlie and protect the insert 3. The frame or carrier may be a moulding of a suitable transparent or translucent material, for example a plastic material such as polycarbonate.

The track 24 extends in the longitudinal direction of the aisle 23 and may be provided with markings such as arrows or words as described previously. The track 24 can be of different lengths depending on the size and/or shape of the side panel 25 to which it is fitted. In a modification (not shown), the track 24 is incorporated into the side panel 25, for example the side panel 25 may be provided with a slot or recess to receive the insert 3.

The photoluminescent tracks 1, 24 above-described may be combined with other features to assist evacuation of the aircraft 10, 20 in an emergency. For example, the position of the exits 10a, 10b, 10c, 10d, 10e may be identified by photoluminescent material on the doors and/or more preferably on the door surround so that the position of the exit can be identified with the door open. The handles and any instructions for opening the doors may also be identified and highlighted by the use of photoluminescent material.

The photoluminescent tracks 1, 24 mounted at or near floor level provide an escape route for passengers to follow if the cabin fills with smoke blocking light from any other source. In addition to these floor mounted tracks, photoluminescent tracks may also be provided at ceiling level to guide passengers to the exits without the presence of smoke in the cabin from a fire or other source. For example, if the main lighting system fails at night or in conditions of low ambient light in the cabin in normal conditions or in an emergency. Thus, electrical emergency lighting systems with separate storage batteries, wiring connections and associated parts may be eliminated entirely by the use of a fully integrated photoluminescent system for emergency lighting and exit identification.

It will be understood that the present invention in each of the aspects described herein is not limited to the embodiments above-described and that various modifications can be made as will be apparent to those skilled in the art.

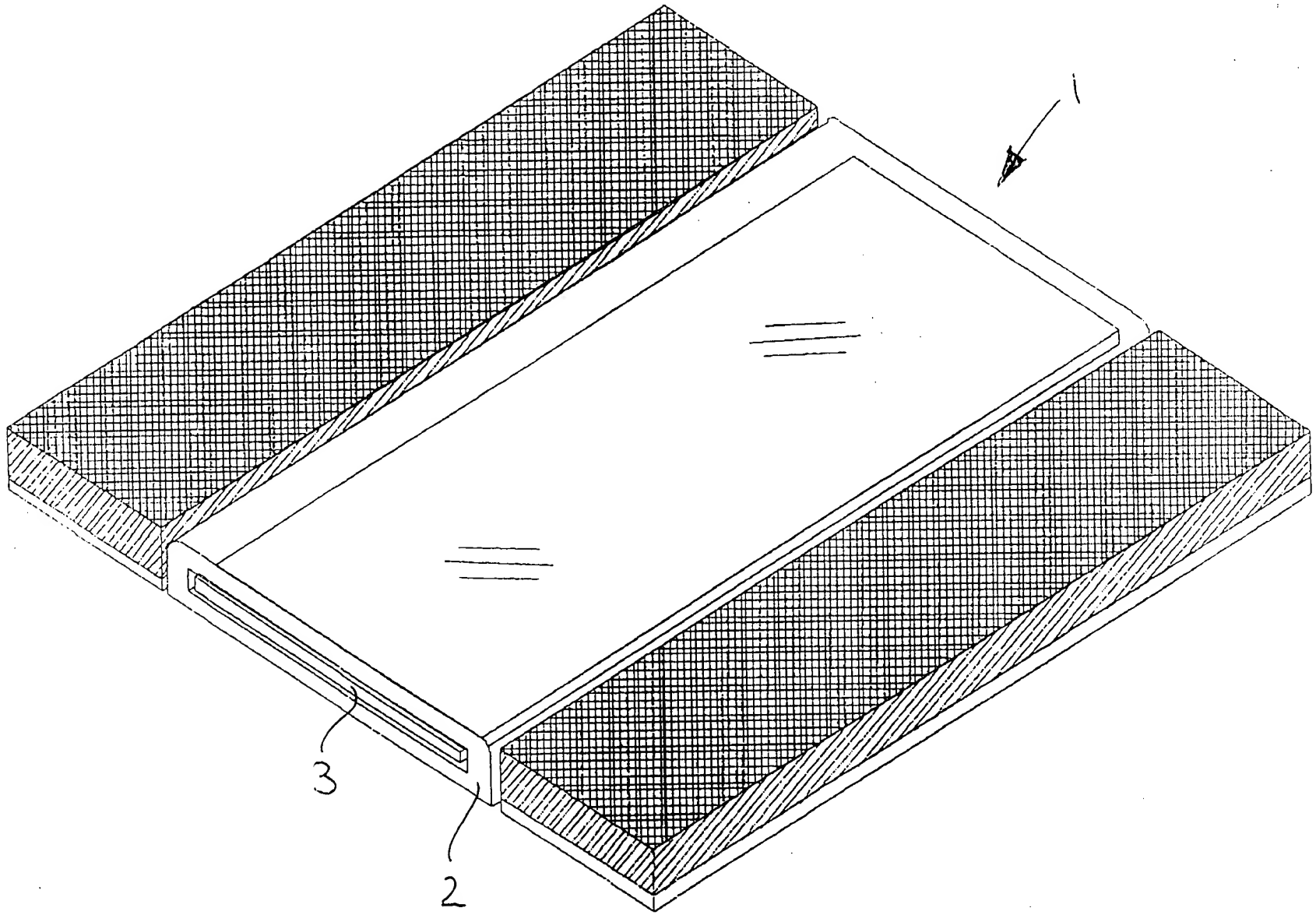

FIGURE 1

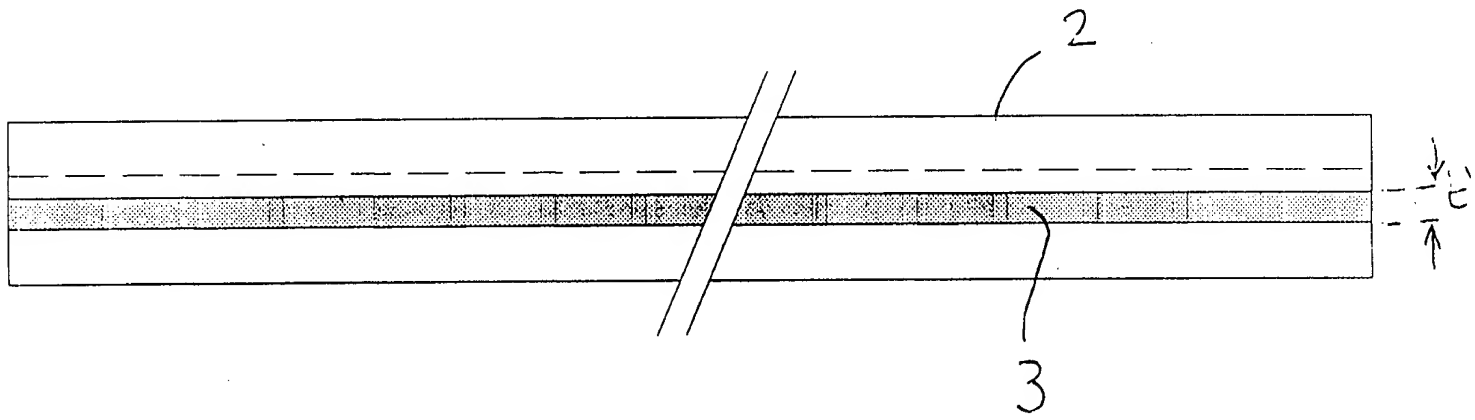

FIGURE 2.

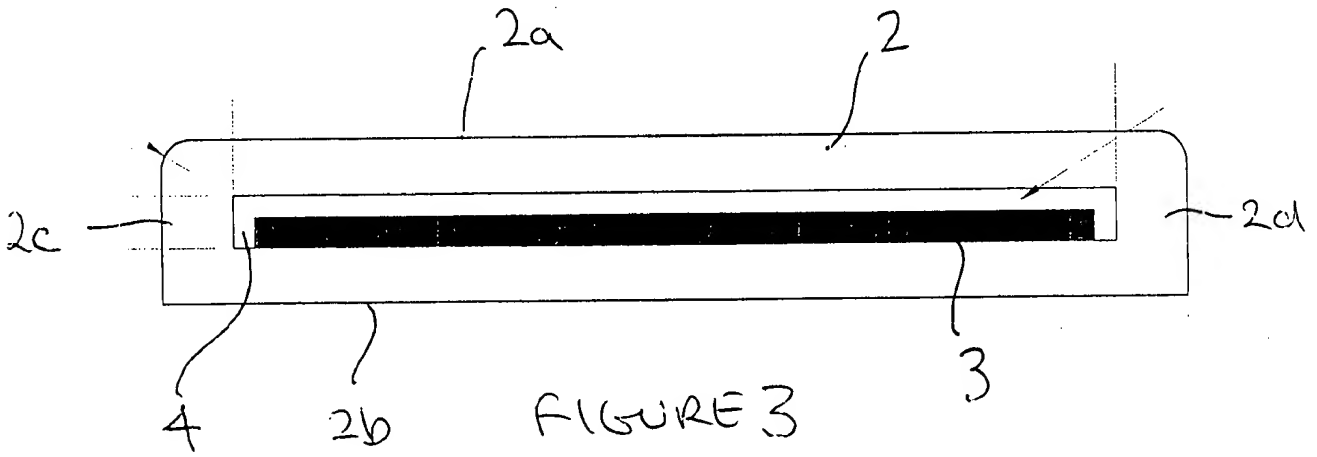

FIGURE 3

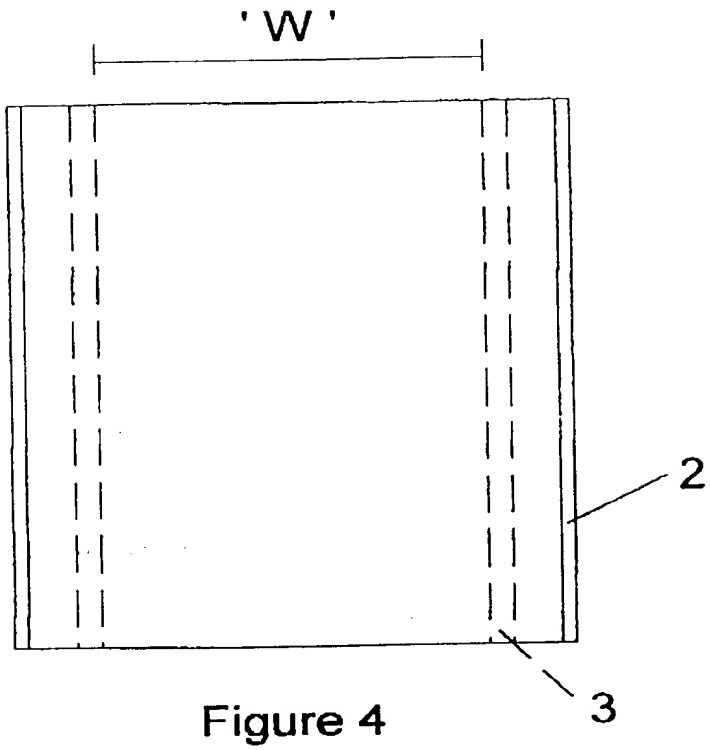

Figure 4

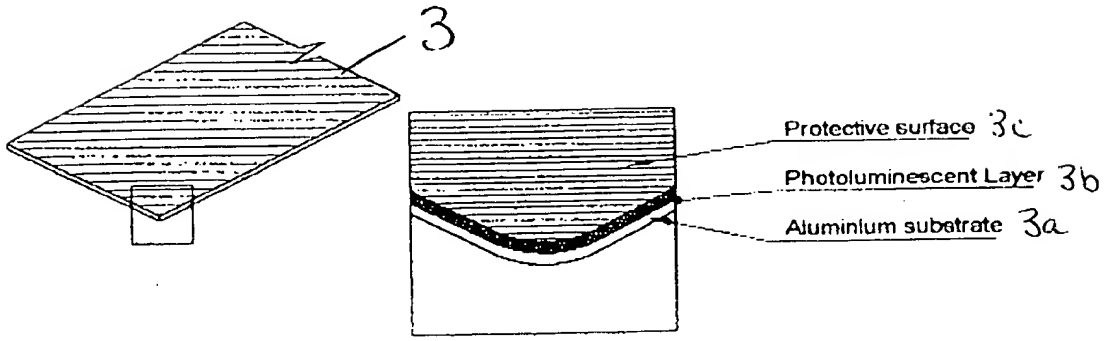

Figure 5

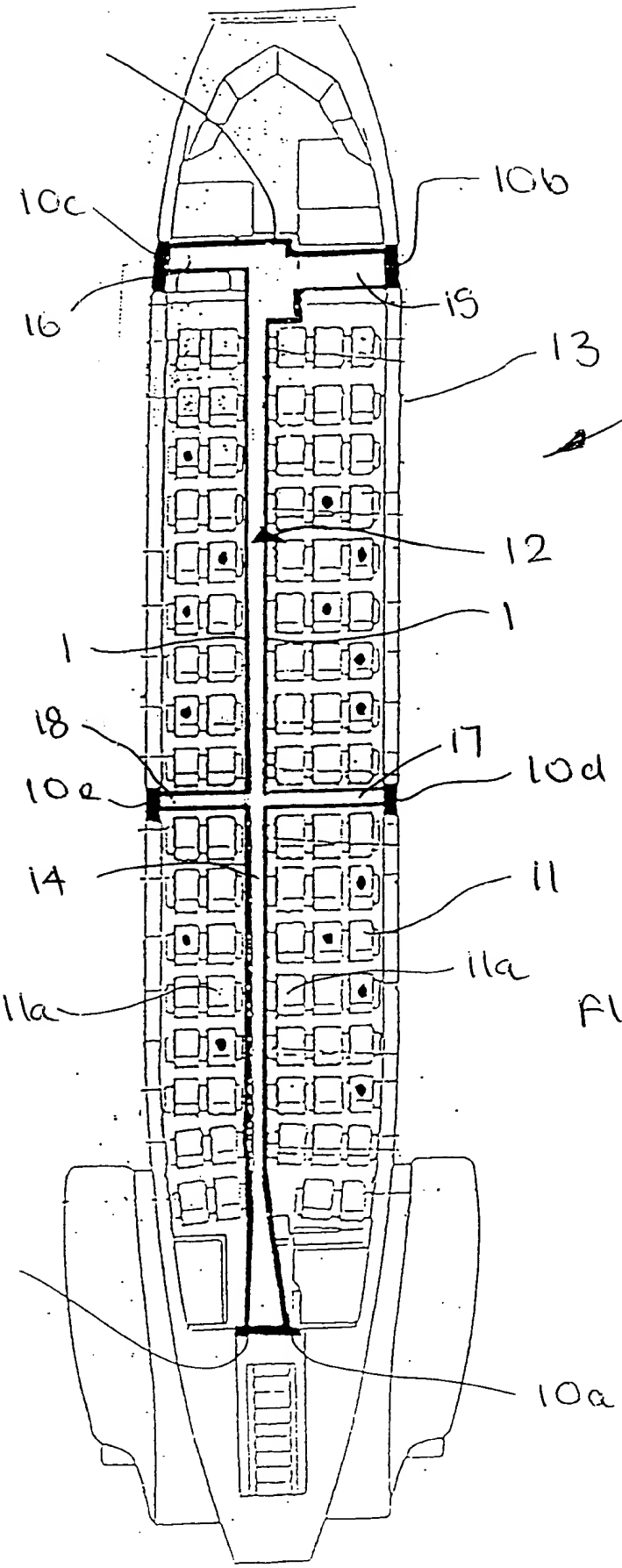

FIGURE 6

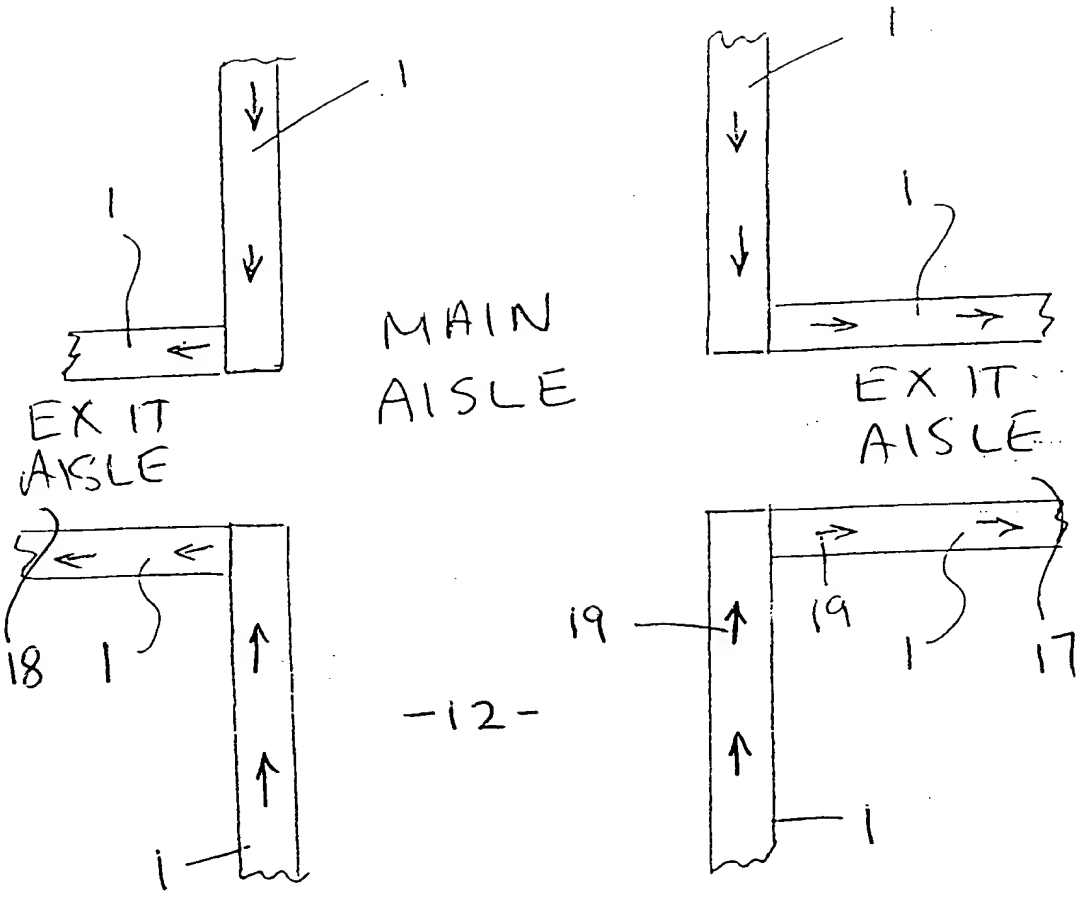

FIGURE 7

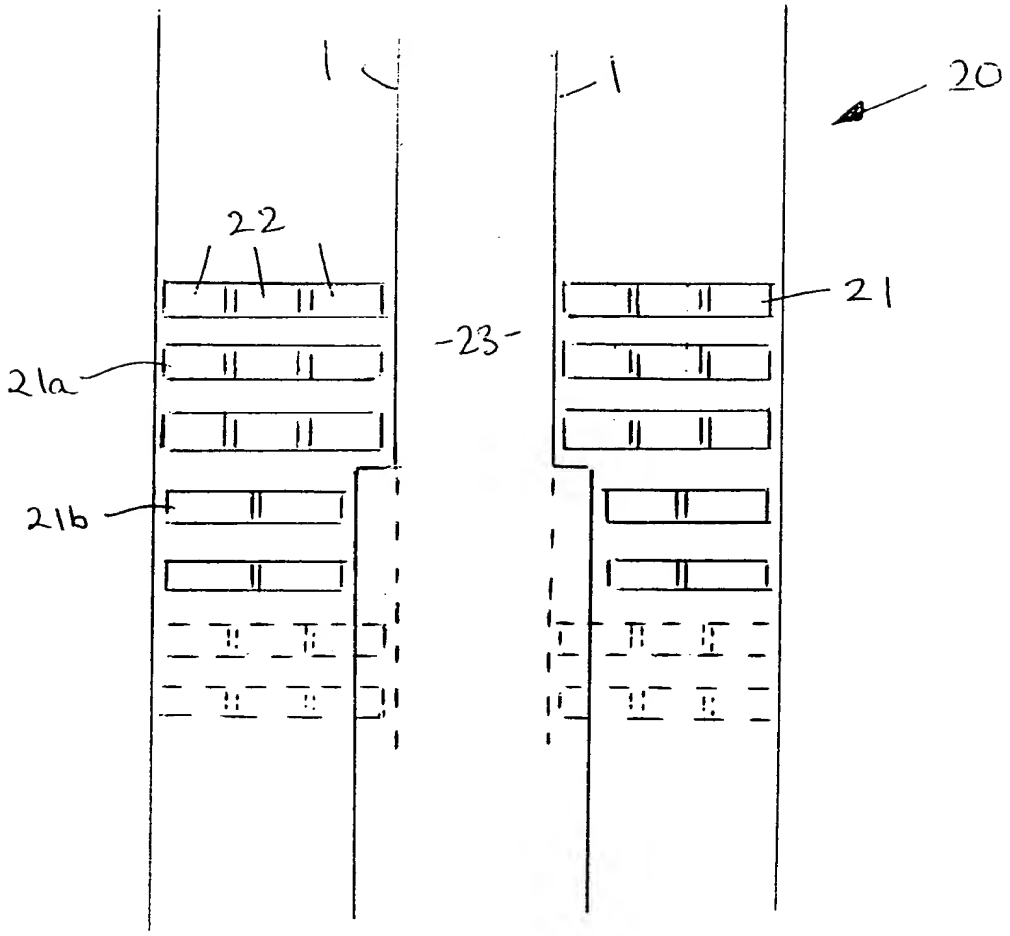

FIGURE 8

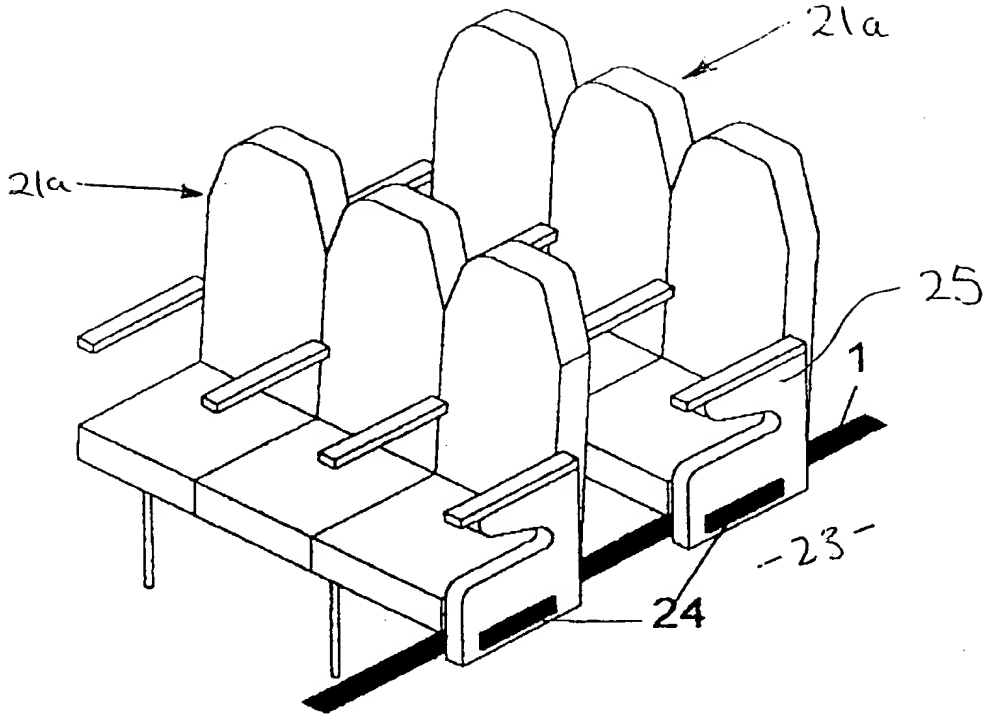

Figure 9